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Article / Book Information

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論 文 要 旨

THESIS SUMMARY

専攻： Department of	土木工学　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of　（　学術　）
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

The phenomenon of internal erosion in cohesionless soils exhibits itself as the gradual migration of fine grains through the voids of the coarse matrix transported by volumes of seepage water. With the erosion of soils, it may cause a loose soil packing and consequently, a reduction in soil strength. This dissertation mainly reveals the mechanical consequences of internal erosion.

To preliminarily understand the mechanism of erosion, seepage tests are conducted in a commonly-used fixed-wall permeameter. A multi-stage test procedure is followed to assess the hydraulic conditions necessary to trigger the internal erosion. Parametric study is conducted to examine the effects of soil properties (i.e., relative density, initial fines content) and hydraulic conditions on the erosion mechanism. The soil strength reduction after erosion in the fixed-wall seepage test is elaborated by interpreting the cone tip resistance profile of the eroded specimens. It is found that internal erosion initiates at a hydraulic gradient much lower than the Terzaghi's critical hydraulic gradient. With the progress of erosion, large amounts of fines would be eroded away and the hydraulic conductivity increases. Erosion of fines would cause the contractive deformation. The specimens with larger initial fines content and looser state would be more vulnerable to erosion. The internal erosion causes a reduction in cone tip resistance, the extent of which may be related to the imposed hydraulic gradient.

A new triaxial permeameter, capable of directly investigating not only the hydraulic characteristics of soils at the onset and the progress of internal erosion under preferred stress state but also the mechanical behaviors of those internally eroded soils, is developed. By installing a sedimentation tank, back pressure could be maintained in the tested specimens during erosion test to ensure a relatively high saturation degree. A system of measuring the cumulative eroded soil mass is installed in the tank to continuously record the eroded soil mass. Erosion tests are performed by constant-flow-rate control with the measurement of the induced pressure difference between the top and the bottom of the tested specimens.

By conducting seepage test in a triaxial condition, the hydromechanical behaviors of tested specimen during the progress of internal erosion are studied by assessing the changes of the key parameters, such as hydraulic gradient, hydraulic conductivity, soil deformation and cumulative eroded soil mass. The effects of effective confining pressure and initial fines content are experimentally investigated. The influence of erosion on the stress ~ strain relationship is directly indicated by conducting undrained & drained monotonic compression test on the internally eroded soil specimen. The influence of effective confining pressure and initial fines content are considered. Influence of internal erosion on the cyclic resistance of tested specimens is studied by performing undrained cyclic test on the eroded soil specimens and companion specimens without erosion, respectively, under the same effective confining pressure.

Test results indicate that under the constant-rate-flow, the hydraulic gradient changes with the progress of internal erosion accompanying with the dislodgement of large amounts of fines. Assigned the seepage flow with the same velocity, the specimens with the larger effective confining pressure show less increments in hydraulic conductivity within the test range. A larger effective confining pressure would cause a less percentage of cumulative fines loss and volumetric strain induced by internal erosion. In terms of initial fines content, a larger fines loss and volumetric strain is observed at the specimens with larger initial fines content. In this series of seepage tests, the tested specimens show contractive behavior and the post-erosion void ratio increases.

Departing from clean sand, an exceptional mechanical behavior of eroded soil is observed. The volumetric strain at failure derived from drained tests reduces with the increasing of effective confining pressure. A temporary drop in soil stiffness at the initial stage of shearing with respect to the axial strain ranging from 0% ~ 1% is observed. In terms of undrained tests, generally, the mobilized friction angle at peak shows trend of increasing with the increasing of effective confining pressure. Compression test results have revealed the probable existence of a reinforced soil packing after internal erosion. The reinforced post-erosion soil packing renders the eroded specimen much stiffer and less compressible. The changes in soil strength after internal erosion are assessed by various criteria. In terms of ASTM criterion, the drained strength of eroded specimens is less than that of original specimens by 20% in average, irrespective of effective confining pressure. The variations in undrained strength appear to be influenced by the effective confining pressure. Mostly, the soil strength decreases after erosion. The critical friction angle of eroded specimen and original specimen, derived from drained monotonic tests, is 35.27° and 36.87°, respectively. At the same normal stress, the shear strength decreases by 5.7% after internal erosion. A larger instability region is observed for the eroded specimens. The cyclic strength increases by two times after internal erosion.